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A Landscape Assessment of the Catskill/Delaware Watersheds 1975-1998

New York City's Water Supply Watersheds

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New York City's Water Supply Watersheds

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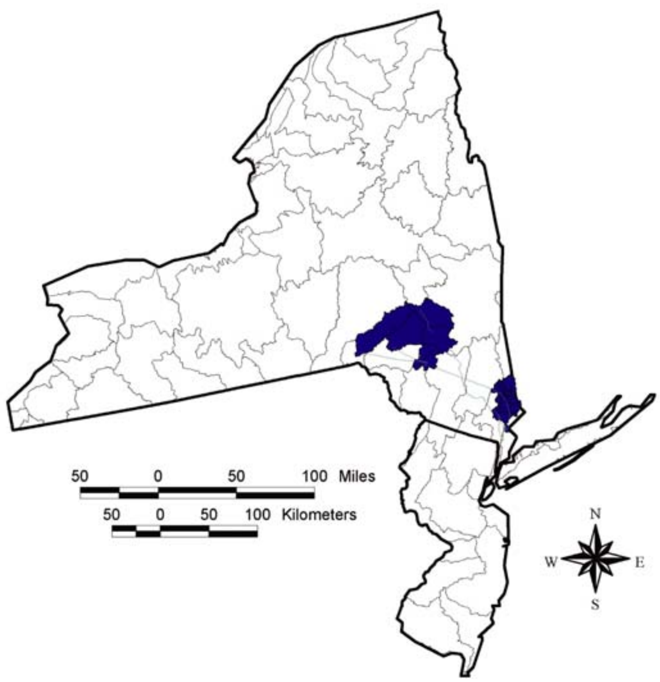

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Notice

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Abbreviations

ATtILA - Analytical Tools Interface for Landscape Assessments
ß - Magnitude of the Coefficients
BMP - best management practice
CI - confidence interval
CD -Catskill/Delaware
DEM - digital elevation model
DLG - digital land graph
EPA - U.S. Environmental Protection Agency
EPIC - Environmental Photographic Interpretation Center
EROS - Earth Resources Observation Systems
FAD - filtration avoidance determination
FC - fecal colifom bacteria
GIS - geographic information system
HUC - hydrologic unit code
LEB - Landscape Ecology Branch
MCL - water maximum contaminant levels
MOA - Memorandum of Agreement
MRLC - Multi-Resolution Land Characteristics
MSS - multispectral scanner
N-index - natural vegetation index
NALC - North American Landscape Characterization
NAPP -National Aerial Photography Program
NDVI - normalized-difference vegetation index
NERL - National Exposure Research Laboratory
NHAP - National High Altitude Photography
NLCD - National Land Cover Data
NRCS - Natural Resource Conservation Service
NYCDEP - New York City Department of Environmental Protection
NYSDEC - New York State Department of Environmental Conservation
ORD - Office of Research and Development
Partial R^2 - partial coefficient of multiple determination
QA - quality assurance
R^2 - coefficient of multiple determination
RF3 - River Reach File, Version 3
STATSGO - State Soil Geographic Data Base
SSURGO - Soil Survey Geographic Data Base
TM - Thematic Mapper
TMDL - total maximum daily load
TN - total nitrogen
TP - total phosphorus
U-Index - human use index
USDA - United States Department of Agriculture
USGS - United States Geological Survey
VIF - variance inflation factor
WSPA - Walton Sewage Treatment Plant (upstream)
WSPB - Walton Sewage Treatment Plant (downstream)

% - percent
CFU - colony forming units
cm - centimeter
ft - foot
g - grams
ha - hectare
in - inch
km - kilometer
L - liter
m - meter
*u*g - microgram
mi - mile
ml - milliliter
mg - milligram
mm - millimeter
sec - second

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Executive Summary

Together the six reservoirs located in the Catskill/Delaware watersheds supply 90% of New York City's drinking water. The 4,100 km^2 (1,583 mi^2) Catskill/Delaware watersheds are located in the southeast corner of New York State, 160 km (100 mi) northwest of New York City. The study summarized here provides (1) regional and local scale data that will assist land managers, policy makers, and the general public in making informed decisions on environmental and water resource issues; and (2) data analyses that help direct future land cover and land use practices critical to maintaining water quality.

The first chapter of the report gives an overview of regional and watershed land cover allowing the reader to compare environmental conditions of the Catskill/Delaware water supply watersheds to other areas within Region 2. The remainder of this report takes a closer look at landscape change, water quality, and land use relationships and trends through time in the Catskill/Delaware watersheds.

There are six watersheds contained within the CD water supply area, each ending in a manmade reservoir. The topography of the area is diverse and, except for the Adirondacks to the north, has the greatest elevation in the state. The landscape of the Catskill/Delaware watersheds has changed little in the past two decades, with forest cover remaining the dominant vegetation in the area. Historically, the Catskill/Delaware watersheds have been dominated by northern hardwoods, including maple, birch, and beech trees. Much of the area was logged prior to the mid-1800s. Today, secondary forest consisting of evergreen and deciduous species covers about 90% of the watersheds. Human use ranges from 0 to 40% of the subwatershed areas, and averages 11% across the entire Catskill/Delaware watersheds. Compared to other watersheds within Region 2, such as those near the Great Lakes and Long Island, which have human use percentages reaching 80%, the environmental disturbance within the Catskill/Delaware watersheds is low. Population has increased by only 15% from 53 to 64 thousand people between 1970 and 1995. However, as a result of topographic constraints, the majority (90%) of urban and agriculture land use is located within a 120-m (395-ft) riparian buffer. The highest amount of human use is located in the less rugged terrain of the northwest and the lowest is in the southeast watersheds.

Only one reservoir, the Cannonsville, exceeds State and Federal total maximum daily load (TMDL) standards for phosphorus. However, all six reservoirs and one stream are currently included on the State 303d list for sediment, phosphorus, or pathogens levels. At lower levels, nitrogen and phosphorus do not pose a threat to either human health or aquatic habitat. However, when the nutrient levels are enriched, eutrophication can occur resulting in algal blooms. Excessive algal growth can disrupt stream habitat, deplete oxygen levels, and raise turbidity, odor, and color to unacceptable levels. When present in the water, fecal coliforms indicate contamination by warm-blooded animal waste. Human health is affected by other pathogens, which may be excreted along with the fecal coliforms, such as bacteria, protozoa, and viruses. In many cases, excessive nutrient and fecal coliform levels are the result of nonpoint pollution related to land use and land use practices. Modifying these practices can improve water quality conditions. However, in a few cases spikes can result from unexpected sources such as migratory bird populations or accidental spills.

Total nitrogen, phosphorus, and fecal coliform data were selected for study because of public concern about the 303d listing of the water supply reservoirs for nutrients and pathogens and the potential linkages to land use. Like patterns of human use, average water quality measurements of nitrogen, phosphorus, and fecal coliforms are highest in the northwest and lowest in the southeast of the Catskill/Delaware watersheds. Monthly averages of nitrogen, phosphorus, and fecal coliform, in general, do not exceed ambient water quality standards. However, in watersheds having the most human use, a few water sampling sites have median and average values that approach or slightly exceed current standards. These are most frequently at sites downstream of sewage treatment facilities.

Multiple regression analysis is used to examine the relationship of landscape metrics to surface water concentrations of total nitrogen, total phosphorus, and fecal coliform. The percentages of agriculture and urban development in the subwatersheds are significantly related to all three water quality measurements. Agriculture is the dominant human use in the subwatersheds and riparian buffer. Results from the regression analyses suggest that as the percentages of agriculture and urban development increase, surface water concentrations of total nitrogen, total phosphorus, and fecal coliform can also be expected to increase. Three other metrics having a significant relationship to water quality parameters, but explaining only a small portion of overall variability in water quality, are percent bare ground, percent agriculture on steep slopes, and percent agriculture on erodible soils within the subwatersheds. Therefore, increases in the percentage of these land uses associated with increased erosion may result in elevating total nitrogen, total phosphorus, and fecal coliform levels in surface water.

Release of agricultural fields from farming has returned a small percentage of land to secondary growth forest. During the past two decades this change has resulted in a 2% net increase in forest cover. The effect of this land cover change is evident in the decreasing contribution of agriculture to total nitrogen concentrations within the surface water from 1987 to 1998. The direction of change in surface water and landscape condition indicates that those measurements of land use significant to single date comparisons are also important to trends in time.

These results suggest targeting the farms in a subwatershed having high percentages of land use types associated with water quality degradation may achieve greater overall pollution reduction to the water supply than random areawide enrollment in farm management programs. Selecting Best Management Programs to initiate would then depend on which pollutant is of highest priority for that subwatershed. Farmers within subwatersheds nearest to the reservoirs and having low stream density should be encouraged to preserve wetland and riparian areas through enrollment in wetland reserve and forest easement programs. These efforts would help buffer streams and reservoirs from nonpoint pollution via runoff from barnyards, pastures, and crop fields.

Another key component to determining water quality is the percent of urban land use within the subwatershed. The current regulations proposed in the Memorandum of Agreement for improving exiting treatment plant performance and restricting new waste treatment plants should help reduce point source inputs in the Catskill/Delaware watersheds. However, in addition to waste treatment plant inputs, high percentages of impervious surfaces have increased discharge rates, sedimentation, and pollutant runoff in a number of the subwatersheds. An urban planning program that helps landowners develop best management practices for golf courses, parks, backyard gardens, and lawns could help address some of the current impacts. Offsetting future land uses will most likely require increasing the percentage of forest cover, particularly in the riparian buffer. One way to help promote more riparian forest is by increasing the setbacks requirements for human use from 30 to 60 or 120 m.

Balancing water quality protection and economic growth requires a great deal of thought, coordination, and cooperation. As demonstrated by the results of this study, human use of the landscape has direct consequences on water quality resources. Even changes as small as 2% can have an effect. Whether or not the change is beneficial to the quality of water supplied by the Catskill/Delaware watersheds, rests on the choices made by those living in the area. Economic and social incentives which encourage forestry, agriculture and urban planning and management for specific subwatershed needs within the Catskill/Delaware watersheds can help facilitate the continued success of long-term watershed management plans set forth in the Memorandum of Agreement.